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Eugenics in Evolutionary Perspective*

I AM HONOURED AT having been twice asked to give the Eugenics Society's Galton Lecture. The first occasion was a quarter of a century ago, when Lord Horder was our President, and I am proud of the remarks which he and my brother Aldous made about these.

Let me begin by broadly outlining how eugenics looks in our new evolutionary perspective. Man, like all other existing organisms, is as old as life. His evolution has taken close on three billion years. During that immense period he—the line of living substance leading to *Homo sapiens*—has passed through a series of increasingly high levels of organization. His organization has been progressively improved, to use Darwin's phrase, from some submicroscopic gene-like state, through a unicellular to a two-layered and a metazoan stage, to a three-layered type with many organ-systems, including a central nervous system and simple brain, on to a chordate with notochord and gill-slits, to a jawless and limbless vertebrate, to a fish, then to an amphibian, a reptile, an unspecialized insectivorous mammal, a lemuroid, a monkey with much improved vision, heightened exploratory urge and manipulative ability, an ape-like creature, and finally through a protohominid australopith to a fully human creature, big-brained and capable of true speech.

This astonishing process of continuous advance and biological improvement has been brought about through the operation of natural selection—the differential reproduction of biologically beneficial combinations of mutant genes, leading to the persistence, improvement and multiplication of some strains, species and

patterns of organization and the reduction and extinction of others, notably to a succession of so-called dominant types, each achieving a highly successful new level of organization and causing the reduction of previous dominant types inhabiting the same environment. During its period of dominance, which may last up to a hundred million years or so, the new type itself becomes markedly improved, whether by specialization of single subtypes like the horses or elephants, or by an improvement in general organization, as happened with the mammalian type in general at the end of the Oligocene. Eventually no further improvement is possible, and further advance can only occur through the breakthrough of one line to a radically new type of organization, as from reptile to mammal.

In biologically recent times, one primate line broke through from the mammalian to the human type of organization. With this, the evolutionary process passed a critical point, and entered on a new state or phase, the psychosocial phase, differing radically from the biological in its mechanism, its tempo, and its results. As a result, man has become the latest dominant type in the evolutionary process, has multiplied enormously, has achieved miracles of cultural evolution, has reduced or extinguished many other species, and has radically affected the ecology and indeed the whole evolutionary process of our planet. Yet he is a highly imperfect creature. He carries a heavy burden of genetic defects and imperfections. As a psychosocial organism, he has not undergone much improvement. Indeed, man is still very much an unfinished type, who clearly has actualized only a small fraction of his human potentialities. In addition, his genetic deterioration is being

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rendered probable by his social set-up, and definitely being promoted by atomic fallout. Furthermore, his economic, technical and cultural progress is threatened by the high rate of increase of world population.

The obverse of man's actual and potential further defectiveness is the vast extent of his possible future improvement. To effect this, he must first of all check the processes making for genetic deterioration. This means reducing man-made radiation to a minimum, discouraging genetically defective or inferior types from breeding, reducing human over-multiplication in general and the high differential fertility of various regions, nations and classes in particular. Then he can proceed to the much more important task of positive improvement. In the not too distant future the fuller realization of possibilities will inevitably come to provide the main motive for man's overall efforts; and a Science of Evolutionary Possibilities, which to-day is merely adumbrated, will provide a firm basis for these efforts. Eugenics can make an important contribution to man's further evolution: but it can only do so if it considers itself as one branch of that new nascent science, and fearlessly explores all the possibilities that are open to it.

Man, let me repeat, is not a biological but a psychosocial organism. As such, he possesses a new mechanism of transmission and transformation based on the cumulative handing on of experience, ideas and attitudes. To obtain eugenic improvement, we shall need not only an understanding of what kind of selection operates in the psychosocial process, not only new scientific knowledge and new techniques in the field of human genetics and reproduction but new ideas and attitudes about reproduction and parenthood in particular and human destiny in general. One of those new ideas will be the moral imperative of Eugenics.



In the twenty-five years since my previous lecture, many events have occurred, and many discoveries have been made with a bearing on eugenics. Events such as the explosion of atomic and nuclear bombs, the equally sinister "population explosion," the *reductio ad horrendum* of racism by Nazi Germany, and the introduction

of artificial insemination for animals and human beings, sometimes with the use of deep-frozen sperm; scientific discoveries such as that of DNA as the essential basis for heredity and evolution, of subgenic organization, of the widespread existence of balanced polymorphic genetic systems, and of the intensity and efficacy of selection in nature; the realization that the entities which evolve are populations of phenotypes, with consequent emphasis on population genetics on the one hand, and on the interaction between genotype and environment on the other; and finally the recognition that adaptation and biological improvement are universal phenomena in life.

I do not propose to discuss these changes and discoveries now, but shall plunge directly into my subject—Eugenics in Evolutionary Perspective. I chose this title because I am sure that a proper understanding of the evolutionary process and of man's place and role in it is necessary for any adequate or satisfying view of human destiny; and eugenics must obviously play an important part in enabling man to fulfil that destiny.

As I have set forth at greater length elsewhere, in the hundred years since the publication of the *Origin of Species* there has been a "knowledge explosion" unparalleled in all previous history. It has led to an accelerated expansion of ideas, not only in the natural sciences but also in the humanistic fields of history, archaeology, and social and cultural development, and its effects on our thinking have been especially violent, not to say revolutionary, during the quarter of a century since my previous Galton Lecture. It has led to a new picture of man's relations with his own nature and with the rest of the universe, and indeed to a new and unified vision of reality, both fuller and truer than any of the insights of the past. In the light of this new vision the whole of reality is seen as a single process of evolution. For evolution can properly be defined as a natural process in time, self-varying and self-transforming and generating increasing complexity and variety during its transformations; and this is precisely what has been going on for all time in all the universe. It operates everywhere and in all periods, but is divisible into a series of three sectors or successive phases, the

inorganic or cosmic, the organic or biological, and the human or psychosocial, each based on and growing out of its predecessor. Each phase operates by a different main mechanism, has a different scale and a different tempo of change, and produces a different type of results.

Between the separate phases, the evolutionary process has to cross a critical threshold, passing from an old to a new state, as when water passes from the solid to the liquid state at the critical temperature-threshold of 0°C and from liquid to gaseous at that of 100°C .

The critical threshold between the inorganic and the biological phase was crossed when matter and the organisms built from it became self-reproducing, that between the biological and the psychosocial when mind and the organizations generated by it became self-reproducing in their turn.

The cosmic phase operates by random interaction, primarily physical but to a small degree chemical. Its quantitative scale is unbelievably vast both in space and time. Its visible dimensions exceed 1,000 million light-years (10^{22}km), its distances are measured by units of thousands of light-years (nearly 10^{16}km), the numbers of its visible galaxies exceed 100 million (10^8) and those of its stars run into thousands of millions of millions (10^{15}). It has operated in its present form for at least 6,000 million years, possibly much longer. Its tempo of major change is unbelievably slow, to be measured by 1,000-million-year periods. According to the physicists, its overall trend, in accord with the Second Law of Thermodynamics, is entropic, tending towards a decrease in organization and to ultimate frozen immobility; and its products reach only a very low level of organization—photons, subatomic particles, atoms, and simple inorganic compounds at one end of its size-scale, nebulae, stars and occasional planetary systems at the other.

The biological phase operates primarily by the teleonomic or ordering process of natural selection, which canalizes random variation into non-random directions of change. Its tempo of major change is somewhat less slow, measured by 100-million- instead of 1,000-million-year units of time. Its overall trend, kept going of course by solar energy, is anti-entropic, towards an increase in the amount and quality of adap-

tive organization, and marked by the growing importance of awareness as mediated by brains. And its results are organisms—organisms of an astonishing efficiency, complexity, and variety, almost inconceivably so until one recalls R. A. Fisher's profound paradox, that natural selection plus time is a mechanism for generating an exceedingly high degree of improbability.

In the course of biological evolution, three sub-processes are at work. The first (cladogenesis, or branching evolution) leads to divergence and greater variety; the second (anagenesis, or upward evolution) leads to improvement of all sorts, from detailed adaptations to specializations, from the greater efficiency of some major function like digestion to overall advance in general organization; the third is stasigenesis or stabilized limitation of evolution. This occurs when specialization for a particular way of life reaches a dead end as with horses, or efficiency of function attains a maximum as with hawks' vision, or an ancient type of organization persists as a living fossil like the lungfish or the tuatara.

Major advance or biological progress is always by a succession of dominant types, each step achieved by a rare breakthrough from some established type of organization to a new and more effective one, as from the amphibian to true dry-land reptilian type, or from the cold-blooded egg-laying reptile to the warm-blooded self-regulating mammal with intra-uterine development. The new dominant type multiplies at the expense of the old, which may become extinct (as did the jawless fish) or may persist in reduced numbers (as did the reptiles.)

The psychosocial phase, the latest of which we have any knowledge (though elsewhere in the universe there may have been a breakthrough to some new phase as unimaginable to us as the psychosocial phase would have been to even the most advanced Pliocene primate), is based on a self-reproducing and self-varying system of cumulative transmission of experience and culture, operating by mechanisms of psychological and social selection which we have not as yet adequately defined or analysed. Spatially it is very limited; we know of it only on this earth, and in any case it must be restricted to the surface of a small minority of planets in the small

minority of stars possessing planetary systems. On our planet it is at the very beginning of its course, having begun less than one million years ago. However, its tempo is not only much faster than that of biological evolution, but manifests a new phenomenon, in the shape of a marked acceleration. Its overall trend is highly anti-entropic, and is characterized by a sharp increase in the operative significance of exceptional individuals and in the importance of true purpose and conscious evaluation based on reason and imagination, as against the automatic differential elimination of random variants.

The most significant element in that trend has been the growth and improved organization of tested and established knowledge. And its results are psychologically (mentally) generated organizations even more astonishingly varied and complex than biological organisms—machines, concepts, cooking, mass communications, cities, philosophies, superstitions, propaganda, armies and navies, personalities, legal systems, works of art, political and economic systems, entertainments, slavery, scientific theories, hospitals, moral codes, prisons, myths, languages, torture, games and sports, religions, record and history, poetry, civil services, marriage systems, initiation rituals, agriculture, drama, social hierarchies, schools and universities. Accordingly evolution in the human phase is no longer purely biological, based on changes in the material system of genetic transmission, but primarily cultural, based on changes in the psychosocial system of ideological and cultural transmission.

In the psychosocial phase of evolution the same three sub-processes operating in the biological phase are still at work—cladogenesis, operating to generate difference and variety within and between cultures; anagenesis, operating to produce improvement in detailed technological methods, in economic and political machinery, in administrative and educational systems, in scientific thinking and creative expression, in moral tone and religious attitude, in social and international organization; and stasigenesis, operating to limit progress and to keep old systems and attitudes, including even outworn superstitions, persisting alongside of or actually within more advanced social and intellectual systems. But there is an additional fourth

sub-process, that of convergence (or at least anti-divergence), operating by diffusion—diffusion of ideas and techniques between individuals, communities, cultures and regions. This is tending to give unity to the world: but we must see to it that it does not also impose uniformity and destroy desirable variety.

As in the biological phase, major advance in the human phase is brought about by a succession of generally or locally dominant types. These, however, are not types of organism, but of cultural and ideological organization. Monotheism as against polytheism, for instance; or in the political sphere, the beginning of one-world internationalism as against competitive multinationalism. Or again, science as against magic, democracy as against tyranny, planning as against *laissez-faire*, tolerance as against intolerance, freedom of opinion and expression as against authoritarian dogma and repression.

Not only does the succession of dominant types bring about progress or advance in organization within each of the three main evolutionary phases, but it also operates, though on a grander and more decisive scale, in the evolutionary process as a whole. A biological organism possesses a higher degree of organization than any inorganic system; as soon as living organisms were produced, they became the major dominant type of organization on earth, and the course of evolution became predominantly biological and only secondarily inorganic. Similarly a psychosocial system possesses a higher degree of organization than any biological organism: accordingly man at once became the new major dominant type on earth, and the course of evolution became predominantly cultural and only secondarily biological, with inorganic methods quite subordinate.

The evolutionary perspective includes the broad background of the cosmic past. Now against this background we must face the problems of the present and the challenge of the future. Let me begin by reiterating that man is an exceedingly recent phenomenon. The earliest creatures which can properly be called men, though they must be assigned to different genera from ourselves, date from less than two million years ago, and our own species, *Homo sapiens*, from much less than half a million years. Man began to put his toe

tentatively across the critical threshold leading towards evolutionary dominance perhaps a quarter of a million years ago, but took tens of thousands of years to cross it, emerging as a dominant type only during the last main glaciation, probably later than 100,000 B.C., but not becoming fully dominant until the discovery of agriculture and stock-breeding well under 10,000 years ago, and overwhelmingly so with the invention of machines and writing and organized civilization a bare five millennia before the present day, when his dominance has become so hubristic as to threaten his own future.

All new dominant types begin their career in a crude and imperfect form, which then needs drastic polishing and improvement before it can reveal its full potentialities and achieve full evolutionary success. Man is no exception to this rule. He is not merely exceedingly young; he is also exceedingly imperfect, an unfinished and often botched product of evolutionary improvisation. Teilhard de Chardin has called the transformation of an anthropoid into a man *hominisation*: it might be more accurately, though more clumsily, termed *psychosocialisation*. But whatever we call it, the process of hominisation is very far from complete, the serious study of its course, its mechanisms and its techniques has scarcely started, and only a fraction of its potential results have been realized. Man, in fact, is in urgent need of further improvement.

This is where eugenics comes into the picture. For though the psychosocial system in and by which man carries on his existence could obviously be enormously improved with great benefit to its members, the same is also true for his genetic outfit.

Severe and primarily genetic disabilities like haemophilia, colour-blindness, mongolism, some kinds of sexual deviation, much mental defect, sickle-cell anaemia, some forms of dwarfism, and Huntington's chorea are the source of much individual distress, and their reduction would remove a considerable burden from suffering humanity. But these are occasional abnormalities. Quantitatively their total effect is insignificant in comparison with the massive imperfection of man as a species, and their reduction appears as a minor operation in comparison with

the large-scale positive possibilities of all-round general improvement.

Take first the problem of intelligence. It is to man's higher level of intelligence that he owes his evolutionary dominance; and yet how low that level still remains! It is now well established that the human I.Q., when properly assayed, is largely a measure of genetic endowment. Consider the difference in brain-power between the hordes of average men and women with I.Q.'s around 100 and the meagre company of Terman's so-called geniuses with I.Q.'s of 160 or over, and the much rarer true geniuses like Newton and Darwin, Tolstoy and Shakespeare, Goya and Michelangelo, Hammurabi and Confucius; and then reflect that, since the frequency curve for intelligence is approximately symmetrical, there are as many stupider people with I.Q.'s below 100 as there are abler ones with I.Q.'s above it.

Recollect also that the great and striking advances in human affairs, as much in creative art and political and military leadership as in scientific discovery and invention, are primarily due to a few exceptionally gifted individuals. Remember that on the established principles of genetics a small raising of average capacity would of necessity result in an upward shifting of the entire frequency curve, and therefore a considerable increase in the absolute numbers of such highly intelligent and well-endowed human beings that form the uppermost section of the curve (as well as a decrease in the numbers of highly stupid and feebly endowed individuals at the lower end).

Reflect further on the fact, originally pointed out by Galton, that there is already a shortage of brains capable of dealing with the complexities of modern administration, technology and planning, and that with the inevitable increase of our social and technical complexity, the greater will that shortage become. It is thus clear that for any major advance in national and international efficiency we cannot depend on haphazard tinkering with social or political symptoms or *ad hoc* patching up of the world's political machinery, or even on improving general education, but must rely increasingly on raising the genetic level of man's intellectual and practical abilities. As I shall later point out, artificial

insemination by selected donors could bring about such a result in practice.

The same applies everywhere in the psychosocial process. For more and better scientists, we need the raising of the genetic level of exploratory curiosity or whatever it is that underlies single-minded investigation of the unknown and the discovery of novel facts and ideas; for more and better artists and writers, we need the raising of the genetic level for disciplined creative imagination; for more and better statesmen, that of the capacity to see social and political situations as wholes, to take long-term and total instead of only short-term and partial views; for more and better technologists and engineers, that of the passion and capacity to understand how things work and to make them work more efficiently; for more and better saints and moral leaders, that of disciplined valuation, of devotion and duty, and of the capacity to love; and for more and better leaders of thought and guides of action we need a raising of the capacity of man's vision and imagination, to form a comprehensive picture, at once reverent, assured and unafraid, of nature and man's relations with it.

These facts and ideas have an important bearing on the so-called race question and the problem of racial equality. I should rather say racial *inequality*, for up till quite recently the naïve belief in the natural inequality of races and people in general, and the inherent superiority of one's own race or people in particular, has almost universally prevailed.

To demonstrate the way in which this point of view permeated even nineteenth-century scientific thought, it is worth recalling that it was largely subscribed to by Darwin in his comments on the Fuegians in the *Voyage of the Beagle*, and in more general but more guarded terms in the *Descent of Man*: and Galton himself, against a similar background of travels among backward tribes and on the basis of his own rather curious method of assessment, concluded that different races had achieved different genetic standards,

so that, for instance, "the average standard of the Negro race is two grades below our own." This type of belief, after being given a pseudo-scientific backing by non-biological theoreticians like Gobineau and Houston Stewart Chamberlain, was used to justify the Nazis' "Nordic" claims to world domination and their horrible campaign for the extermination of the "inferior, non-Aryan race" of Jews, and is still employed with support from Holy Writ and the majority of the Dutch Reformed Church in South Africa, to sanction Verwoerd's denial of full human rights to non-whites.

Later investigation has conclusively demonstrated first, that there is no such thing as a "pure race." Secondly, that the obvious differences in level of achievement between different peoples and ethnic groups are primarily cultural, due to differences not in genetic equipment but in historical and environmental opportunity. And thirdly, that when the potentialities of intelligence of two major "races" or ethnic groups, such as whites and negroes or Europeans and Indians, are assessed as scientifically as possible, the frequency curves for the two groups overlap over almost the whole of their extent, so that approximately half the population of either group is genetically stupider (has a lower genetic I.Q.) than the genetically more intelligent half of the other. There are thus large differences in genetic mental endowment *within* single racial groups, but minimal ones *between* different racial groups.

Partly as a result of such studies, but also of the prevalent environmentalist views of Marxist and Western liberal thought, an anti-genetic view has recently developed about race. It is claimed that though ethnic groups obviously differ in physical characters, and that some of them, like pigmentation, nasal form, and number of sweat-glands, were originally adaptive, they do not (and sometimes even that they cannot) differ in psychological or mental characters such as intelligence, imagination, or even temperament.*

Against this new pseudo-scientific racial naïveté, we must set the following scientific facts and principles. First, it is clear that the major human races originated as geographical subspecies of *Homo sapiens*, in adaptation to the very different environments to which they have

* There is the further point that races may differ considerably in body-build and that Sheldon and others have made it highly probable that body-build is correlated with temperament. Unfortunately, racial differences in body-build have not yet been analysed in terms of Sheldon's somatotypes: here is an important field for research.

become restricted. Later, of course, expansion and migration reversed the process of differentiation and led to an increasing degree of convergence by crossing, though considerable genetic differentiation remains. Secondly, as Professor Muller has pointed out, it is theoretically inconceivable that such marked physical differences as still persist between the main racial groups should not be accompanied by genetic differences in temperament and mental capacities, possibly of considerable extent. Finally, as previously explained, advance in cultural evolution is largely and increasingly dependent on exceptionally well-endowed individuals. Thus two racial groups might overlap over almost the whole range of genetic capacity, and yet one might be capable of considerably higher achievement, not merely because of better environmental and historical opportunity, but because it contained say 2 instead of 1 per cent of exceptionally gifted men and women. So far as I know, proper scientific research on this subject has never been carried out, and possibly our present methods of investigation are not adequate for doing so, but the principle is theoretically clear and is of vital practical importance.*

This does not imply any belief in crude racism, with its unscientific ascription of natural and permanent superiority or inferiority to entire races. As I have just pointed out, approximately half of any large ethnic group, however superior its self-image may be, is in point of fact genetically inferior to half of the rival ethnic group with which it happens to be in social or economic competition and which it too often stigmatizes as permanently and inherently lower. Furthermore, practical experience demonstrates that every so-called race, however underdeveloped its economic and social system may happen to be, contains a vast reservoir of untapped talent, only

waiting to be elicited by a combination of challenging opportunity, sound educational methods, and efficient special training. I recently attended an admirable symposium on nutrition in Nigeria where the scientific quality of the African contributions was every whit as high as that of the whites; and African politicians can be just as statesmanlike (and also just as unscrupulously efficient in the political game) as their European or American counterparts.

The basic fact about the races of mankind is their almost total overlap in genetic potentialities. But the most significant fact for eugenic advance is the large difference in achievement made possible by a small increase in the number of exceptional individuals.

The evolutionary biologist can point out to the social scientist and the politician that this importance of the exceptional individual for psychosocial advance is merely an enhancement of a long-established evolutionary trend. Exceptional individuals can be important for biological improvement in mammals, in birds, and possibly even in insects. New food-traditions in Japanese monkeys are established by disobedient young individuals. The utilization of milk-bottles as a new source of food by blue tits was due to the activities of a few exceptional tit geniuses in a few widely separate localities. All male satin bowerbirds construct bowers and assemble collections of stimulating bright objects at them, but only a minority deliberately paint their bowers with a mixture of berries, charcoal and saliva, and only a still smaller minority indulge the species' natural preference for blue objects by deliberately stealing bluebags to add to their display collection. And there is some evidence that even in ants, those prototypes of rigidly instinctive behaviour, a few workers are exceptionally well-endowed with the exploratory urge, and play a special role in discovering new sources of food for the colony.

But I must return to man as a species. The human species is in desperate need of genetic improvement if the whole process of psychosocial evolution which it has set in train is not to get bogged down in unplanned disorder, negated by over-multiplication, clogged up by mere complexity, or even blown to pieces by obsessional stupidity. Luckily it not only *must*

* On the supposition that genetic intelligence is multifactorially (polygenically) determined and that its distribution follows a normal symmetrical curve, it can be calculated that the raising of the mean genetic I.Q. of a population by $1\frac{1}{2}$ per cent would result in a 50 per cent increase in the number of individuals with an I.Q. of 160 or over. The proportion of such highly-endowed individuals would rise from 1 in about 30,000 of the total population to 1 in about 20,000. Sir Cyril Burt informs me that if, as is possible, some types of high genetic intelligence are determined by single genes, the increase might be still greater.

but *can* be improved. It can be improved by the same type of method that has secured the improvement of life in general—from protozoan to protovertebrate, from protovertebrate to primate, from primate to human being—the method of multi-purpose selection directed towards greater achievement in the prevailing conditions of life.

On the other hand, it can *not* be improved by applying the methods of the professional stock-breeder. Indeed the whole discussion of eugenics has been bedevilled by the false analogy between artificial and natural selection. Artificial selection is intensive special-purpose selection, aimed at producing a particular excellence, whether in milk-yield in cattle, speed in race-horses or a fancy image in dogs. It produces a number of specialized pure breeds, each with a markedly lower variance than the parent species. Darwin rightly drew heavily on its results in order to demonstrate the efficacy of selection in general. But since he never occupied himself seriously with eugenics he did not point out the irrelevance of stock-breeding methods to human improvement. In fact, they are not only irrelevant, but would be disastrous. Man owes much of his evolutionary success to his unique variability. Any attempt to improve the human species must aim at retaining this fruitful diversity, while at the same time raising the level of excellence in all its desirable components, and remembering that the selectively evolved characters of organisms are always the results of compromise between different types of advantage, or between advantage and disadvantage.

Natural selection is something quite different. To start with, it is a shorthand metaphorical term coined by Darwin to denote the teleonomic or directive agencies affecting the process of evolution in nature, and operating through the differential survival and reproduction of genetical variants. It may operate between conspecific individuals, between conspecific populations, between related species, between higher taxa such as genera and families, or between still larger groups of different organizational type, such as Orders and Classes. It may also operate between predator and prey, between parasite and host, and between different synergic assemblages of species, such as symbiotic partnerships and ecological communities. It is in fact universal in

its occurrence, though multiform in its mode of action.

Some over-enthusiastic geneticists appear to think that natural selection acts directly on the organism's genetic outfit or genotype. This is not so. Natural selection exerts its effects on animals and plants as working mechanisms: it can operate only on phenotypes. Its evolutionary action in transforming the genetic outfit of a species is indirect, and depends on the simple fact pointed out by Darwin in the *Origin* that much variation is heritable—in modern terms, that there is a high degree of correlation between phenotypic and genotypic variance. The correlation, however, is never complete, and there are many cases where it is impossible without experimental analysis to determine whether a variant is modificational, due to alteration in the environment, or mutational, due to alteration in the genetic outfit. In certain cases, environmental treatment will produce so-called phenocopies which are indistinguishable from mutants in their visible appearance.

This last fact has led Waddington to an important discovery—the fact that an apparently Lamarckian mode of evolutionary transformation can be precisely simulated by what he calls genetic assimilation. To take an actual example, the rearing of fruitfly larvae on highly saline media produces a hypertrophy of their salt-excreting glands through direct modification. But if selection is practised by breeding from those individuals which show the maximum hypertrophy of their glands, then after some ten or twelve generations, individuals with somewhat hypertrophied glands appear even in cultures on non-saline media. The species has a genetic predisposition, doubtless brought by selection in the past, to react to saline conditions by glandular hypertrophy. The action of the major genes concerned in reactions of this sort can be enhanced (or inhibited) by so-called modifying genes of minor effect. Selection has simply amassed in the genetic outfit an array of such minor enhancing genes strong enough to produce glandular hypertrophy even in the absence of any environmental stimulus. It is only pseudo-Lamarckism, but no less important for that—a significant addition to the theoretical armoury of evolutionary science.

I repeat that the most important effect achieved by natural selection is biological improvement. As G. G. Simpson reminds us, it does so opportunistically, making use of whatever new combination of existing mutant genes, or less frequently of whatever new mutations, happens to confer differential survival value on its possessors. We know of numerous cases where phenotypically identical and adaptive transformations have been produced by different genes or gene-combinations.

Here I must digress a moment to discuss the concept of evolutionary fitness. The biological *avant garde* has chosen to define *fitness* as "net reproductive advantage," to use the actual words employed by Professor Medawar in his Reith Lectures on *The Future of Man*. Any strain of animal, plant, or man which leaves slightly more descendants capable of reproducing themselves than another, is then defined as "fitter." This I believe to be an unscientific and misleading definition. It disregards all scientific conventions as to priority, for it bears no resemblance to what Spencer implied or intended by his famous phrase the *survival of the fittest*.^{*} It is also nonsensical in every context save the limited field of population genetics. In biology, fitness must be defined, as Darwin did with improvement, "in relation to the conditions of life"—in other words, in the context of the general evolutionary situation. I shall call it *evolutionary fitness*, in contradistinction to the purely reproductive fitness of the evangelists of geneticism, which I prefer to designate by the descriptive label of *net* or *differential reproductive advantage*.

Meanwhile, I have a strong suspicion that the genetical *avant garde* of to-day will become the rearguard of tomorrow. In my own active career I have seen a reversal of this sort in relation to natural selection and adaptation. During the first two decades of this century the biological *avant garde* dismissed topics such as cryptic or mimetic coloration, and indeed most discussion of adaptation, as mere "armchair speculation," and played down the role of natural selection in evolution, as against that of large and random mutation. Bateson's enthusiasm rebounded from

his early protest against speculative phylogeny into the far more speculative suggestion made *ex cathedra* at a British Association meeting, that all evolution, whether of higher from lower, or of diversity from uniformity, had been brought about by loss mutations; and the great T. H. Morgan once permitted himself to state in print that, if natural selection had never operated, we should possess all the organisms that now exist and a great number of other types as well! This anti-selectionist *avant garde* of fifty years back has now come over *en masse* into the selectionist camp, leaving only a few retreating stragglers to deliver some rather ineffective parthian shots at their opponents.

Natural selection is a teleonomic or directional agency. It utilizes the inherent genetic variability of organisms provided by the raw material of random mutation and chance recombination, and it operates by the simple mechanism of differential reproductive advantage. But on the evolutionary time-scale it produces biological improvement, resulting in a higher total and especially a higher upper level of evolutionary fitness, involving greater functional efficiency, higher degrees of organization, more effective adaptation, better self-regulating capacity, and finally more mind—in other words an enrichment of qualitative awareness coupled with more flexible behaviour.

Man almost certainly has the largest reservoir of genetical variance of any natural species: selection for the differential reproduction of desirable permutations and combinations of the elements of this huge variance could undoubtedly bring about radical improvement in the human organism, just as it has in pre-human types. But the agency of human transformation cannot be the blind and automatic natural selection of the pre-human sector. That, as I have already stressed, has been relegated to a subsidiary role in the human phase of evolution. Some form of psychosocial selection is needed, a selection as non-natural as are most human activities, such as wearing clothes, going to war, cooking food, or employing arbitrary systems of communication. To be effective, such "non-natural" selection must be conscious, purposeful and planned. And since the tempo of cultural evolution is many thousands of times faster than that of biological

^{*} Darwin did not use the phrase in the first edition of the *Origin of Species*, though in later editions he added it as an equivalent to natural selection.

transformation, it must operate at a far higher speed than natural selection if it is to prevent disaster, let alone produce improvement.

Luckily there is to-day at least the possibility of meeting both these prerequisites: we now possess an accumulation of established knowledge and an array of tested methods which could make intelligent, scientific and purposeful planning possible. And we are in the process of discovering new techniques which could raise the effective speed of the selective process to a new order of magnitude. The relevant new knowledge mainly concerns the various aspects of the evolutionary process—the fact that there are no absolutes or all-or-nothing effects in evolution and that all organisms and all their phenotypic characters represent a compromise or balance between competing advantages and disadvantages; the effect of selection on populations in different environmental conditions; the origin of adaptation; and the general improvement of different evolutionary lines in relation to the conditions of their life. The notable new techniques include effective methods of birth-control, the successful development of grafted fertilized ova in new host-mothers, artificial insemination, and the conservation of function in deep-frozen gametes.

We must first keep in mind the elementary but often neglected fact that the characters of organisms which make for evolutionary success or failure, are not inherited as such. On the contrary, they develop anew in each individual, and are always the resultant of an interaction between genetic determination and environmental modification. Biologists are often asked whether heredity or environment is the more important. It cannot be too often emphasized that the question should never be asked. It is as logically improper to ask a biologist to answer it as it is for a prosecuting counsel to ask a defendant when he stopped beating his wife. It is the phenotype which is biologically significant and the phenotype is a resultant produced by the complex interaction of hereditary and environmental factors. Eugenics, in common with evolutionary biology in general, needs this phenotypic approach.

Man's evolution occurs on two different levels and by two distinct methods, the genetic, based

on the transmission and variation of genes and gene-combinations, and the psychosocial or cultural, based on the transmission and variation of knowledge and ideas.

Professor Medawar, in his Reith Lectures on *The Future of Man*, while admitting in his final chapter that man possesses "a new, non-genetical, system of heredity and evolution" (p. 88), claims on p. 41 that this is "a new kind of biological evolution (I emphasize, a biological evolution)." I must insist that this is incorrect. The psychosocial process—in other words, evolving man—is a new *state* of evolution, a new *phase* of the cosmic process, as radically different from the pre-human biological phase as that is from the inorganic or pre-biological phase; and this fact has important implications for eugenics.

An equally elementary but again often neglected fact is that organisms are not significant—in plain words, are meaningless—except in relation to their environment. A fish is not a thing-in-itself: it is a type of organism evolved in relation to an active life in large or medium-sized bodies of water. A cactus has biological significance only in relation to an arid habitat, a woodpecker only in relation to an arboreal one. Man, however, is in a unique situation. He must live not only in relation with the physico-chemical and biological environment provided by nature, but with the psychosocial environment of material and mental habitats which he has himself created.

Man's psychosocial environment includes his beliefs and purposes, his ideals and his aims: these are concerned with what we may call the habitat of the future, and help to determine the *direction* of his further evolution. All evolution is directional and therefore relative. But whereas the direction of biological evolution is related to the continuing improvement of organisms in relation to their conditions of life, human evolution is related to the improvement of the entire psychosocial process, including the human organism, in relation to man's purposes and beliefs, long-term as well as short-term. Only in so far as those purposes and beliefs are grounded on scientific and tested knowledge, will they serve to steer human evolution in a desirable direction. In brief, biological evolution is given

direction by the blind and automatic agency of natural selection operating through material mechanisms, human evolution by the agency of psychosocial guidance operating with the aid of mental awareness, notably the mechanisms of reason and imagination.

To be effective, such awareness must clearly be concerned with man's environmental situation as well as his genetic equipment. In my first Galton Lecture, I pointed out the desirability of eugenicists relating their policies to the social environment. To-day I would go further, and stress the need for planning the environment in such a way as will promote our eugenic aims. By 1936, it was already clear that the net effect of present-day social policies could not be eugenic, and was in all probability dysgenic. But, as Muller has demonstrated, this was not always so. In that long period of human history during which our evolving and expanding hominid ancestors lived in small and tightly knit groups competing for territorial and technological success, the social organization promoted selection for intelligent exploration of possibilities, devotion and co-operative altruism: the cultural and the genetic systems reinforced each other. It was only much later, with the growth of bigger social units of highly organized civilizations based on status and class differentials, that the two became antagonistic; the sign of genetic transformation changed from positive to negative and definite genetic improvement and advance began to halt, and gave way to the possibility and later the probability of genetic regression and degeneration.

This probability has been very much heightened during the last century, partly by the differential multiplication of economically less favoured classes and groups in many parts of the world, partly by the progress of medicine and public health, which has permitted numbers of genetically defective human beings to survive and reproduce; and to-day it has been converted into a certainty by the series of atomic and nuclear explosions which have been set off since the end of the last war. There is still dispute as to the degree of damage this has done to man's genetic equipment. There can be no dispute as to the fact of damage: any addition to man's load of mutations can only be deleterious, even

if some of them may possibly come to be utilized in neutral or even favourable new gene-combinations.

Now that we have realized these portentous facts, it is up to us to reverse the process and to plan a society which will favour the increase instead of the decrease of man's desirable genetic capacities for intelligence and imagination, empathy and co-operation, and a sense of discipline and duty.

The first step must be to frame and put into operation a policy designed to reduce the rate of human increase before the quantitative claims of mere numbers override those of quality and prevent any real improvement, social and economic as much as eugenic. I would prophesy that within a quite short time, historically speaking, we shall find ourselves aiming at an absolute reduction of the population in the world in general, and in overcrowded countries like Britain, India and China, Japan, Java and Jamaica in particular; the quantitative control of population is a necessary prerequisite for qualitative improvement, whether psychosocial or genetic.

Science seems to be nearing a breakthrough to cheap and simple methods of birth-control, or reproduction-control as it should more properly be called. The immediate needs are for much-increased finance for research, testing, pilot projects, motivation studies and the education of public opinion, and an organized campaign against the irrational attitudes and illiberal policies of various religious and political organizations. Simultaneously, responsible opinion must begin to think out ways in which social and economic measures can be made to promote desirable genetic trends and reproductive habits.

Many countries have instituted family allowance systems which are not graded according to number of children, and some, like France, even provide financial inducements which encourage undesirably large families. It should be easy to devise graded family allowance systems in which the allowances for the first two or three children would be really generous, but those for further children would rapidly taper off. In India, there have even been proposals to tax parents for children above a certain number, and in some

provinces, men fulfilling certain conditions are paid to be vasectomized.

A powerful weapon for adequate population-control is ready to the hand of the great grant-giving and aid-providing agencies of the modern world—international agencies such as the UN and its Technical Assistance Board representing its various Specialized Agencies like F.A.O. and Unesco, the World Bank and the International Finance Corporation Administration; national agencies like the Colombo Plan and the Inter-American Development Fund; and the great private Foundations (wittily categorized as *philanthropoid* by that remarkable man Frederick Keppel) like Rockefeller and Ford, Gulbenkian, Nuffield and Carnegie.

At the moment, much of the financial and technical aid provided by these admirable bodies is being wasted by being flushed down the drain of excess population instead of into the channels of positive economic and cultural development, or is even defeating its own ends by promoting excessive and over-rapid population-increase.

Bankers do not make loans unless they are satisfied of the borrower's credit-worthiness. Surely these powerful agencies, public or private, should not provide loans or grants or other aid unless they are satisfied of the recipient nation's demographic credit-worthiness. If an under-developed nation's birth-rate is excessive, the aid will go in providing the basic minima of food, care, shelter and education for the flood of babies, instead of the capital and the technical skills needed to achieve the breakthrough to a viable industrialization. Wherever this is so, the aid-providing institution should insist that the nation should frame an approved policy of population-control, and that some of the aid should be devoted to the implementation of that policy and to research on the subject. And the U.N. should, of course, take steps to prepare the way for a World Population Policy, should carry out or in any case encourage research on population-control, and should ensure that its Specialized Agencies like W.H.O., Unesco, F.A.O. and I.L.O., pay due attention to the

problems of population in relation to their special fields of competence.

At last I reach my specific subject—eugenics, with its two aspects, negative and positive. Negative eugenics aims at preventing the spread and especially the increase of defective or undesirable human genes or gene-combinations, positive eugenics at securing the reproduction and especially the increase of favourable or desirable ones.*

Negative eugenics has become increasingly urgent with the increase of mutations due to atomic fallout, and with the increased survival of genetically defective human beings, brought about by advances in medicine, public health, and social welfare. But it must, of course, attempt to reduce the incidence, or the manifestation, of every kind of genetic defect. Such defects include high genetic proneness to diseases such as diabetes, schizophrenia (which affects 1 per cent of the entire human population), other insanities, myopia, mental defect and very low I.Q., as well as more clear-cut defects like colour-blindness or haemophilia.

When defects depend on a single dominant gene, as with Huntington's chorea, transmission can of course be readily prevented by persuading the patient to refrain from reproducing himself. With sexlinked defects like haemophilia, Duchenne-type muscular dystrophy, or HCN "smell-blindness," this will help, but the method should be supplemented by counselling his sisters against marriage. This will be more effective and more acceptable when, as seems possible, we can distinguish carriers heterozygous for the defect from non-carriers. This is already practicable with some autosomic recessive defects, notably sickle-cell anaemia. Here, registers of carriers have been established in some regions, and they are being effectively advised against intermarriage. This will at least prevent the manifestation of the defect. The same could happen with galactosaemia, and might be applicable to relatives of patients with defects like phenylketonuria and agammaglobulinaemia.

In addition, the marked differential increase of lower-income groups, classes and communities during the last hundred years cannot possibly be eugenic in its effects. The extremely high fertility of the so-called problem group in the

* In the past, these aims have been generally expressed in terms of defective or desirable *stocks* or *strains*. With the progress of genetics, it is better to reformulate them in terms of genes.

slums of many industrial cities is certainly anti-eugenic.

As Muller and others have emphasized, unless these trends can be checked or reversed, the human species is threatened with genetic deterioration, and unless this load of defects is reduced, positive eugenics cannot be successfully implemented. For this we must reduce the reproduction rate of genetically defective individuals; that is negative eugenics.

The implementation of negative eugenics can only be successful if family planning and eugenic aims are incorporated into medicine in general and into public health and other social services in particular. Its implementation in practice will depend on the use of methods of contraception or sterilization, combined where possible with A.I.D. (artificial insemination by donor) or other methods of vicarious parenthood. In any case, negative eugenics is of minor evolutionary importance and the need for it will gradually be superseded by efficient measures of positive eugenics.

In cases of specific genetic defect, voluntary sterilization is probably the best answer.* In the defective married male, it should be coupled with artificial parenthood (A.P.) by donor insemination (A.I.D.) as the source of children. In the defective female, the fulfilments of child-rearing and family life will have to be secured by adoption until such time—which may not be very distant—as improved technique makes possible artificial parenthood by transfer of fertilized ova, which we may call A.O.D. In both cases, it must be remembered that sterilization does not prevent normal healthy and happy sexual intercourse.

Certified patients are now prevented from reproducing themselves by being confined in mental hospitals. If sterilized, they might be allowed to marry if this were considered likely to ameliorate their condition.

In the case of the so-called social problem group, somewhat different methods will be needed. By social problem group I mean the people, all too familiar to social workers in large cities, who seem to have ceased to care, and just

carry on the business of bare existence in the midst of extreme poverty and squalor. All too frequently they have to be supported out of public funds, and become a burden on the community. Unfortunately they are not deterred by the conditions of existence from carrying on with the business of reproduction: and their mean family size is very high, much higher than the average for the whole country.

Intelligence and other tests have revealed that they have a very low average I.Q.; and the indications are that they are genetically subnormal in many other qualities, such as initiative, pertinacity, general exploratory urge and interest, energy, emotional intensity, and will-power. In the main, their misery and improvidence is not their fault but their misfortune. Our social system provides the soil on which they can grow and multiply, but with no prospects save poverty and squalor.

Here again, voluntary sterilization could be useful. But our best hope, I think, must lie in the perfection of new, simple and acceptable methods of birth-control, whether by an oral contraceptive or perhaps preferably by immunological methods involving injections. Compulsory or semi-compulsory vaccination, inoculation and isolation are used in respect of many public health risks: I see no reason why similar measures should not be used in respect of this grave problem, grave both for society and for the unfortunate people whose increase has been actually encouraged by our social system.

Many social scientists and social workers in the West, as well as all orthodox Marxists, are environmentalists. They seem to believe that all or most human defects, including many that western biologists would regard as genetic, can be dealt with, cured or prevented by improving social environment and social organization. Even some biologists, like Professor Medawar, agree in general with this view, though he admits a limited role for negative eugenics, in the shape of what he calls "genetic engineering." For him, the "newer solution" of the problem, which "goes some way towards making up for the inborn inequalities of man," is simply to improve the environment. With this I cannot agree. Although certain particular problems can be dealt with in this way, for instance proneness to

* It will be even more satisfactory if, as now appears likely, reversible male sterilization (vasectomy) becomes practicable.

tuberculosis by improving living conditions and preventing infection, such methods cannot cope with the general problem of genetic deterioration, because this, if not checked, will steadily increase through the accumulation of mutant genes which otherwise would have been eliminated.

It is true that many diseases or defects with a genetic basis, like diabetes or myopia, can be cured by treatment, though almost always with some expense, trouble, or discomfort to the defective person as well as to society. But if the incidence of such defects (not to mention the many others for which no cure or remedy is now known) were progressively multiplied, the burden would grow heavier and heavier and eventually wreck the social system. As in all other fields, we need to combine environmental and genetic measures, and if possible render them mutually reinforcing.

Against the threat of genetic deterioration through nuclear fall-out there are only two courses open. One is to ban all nuclear weapons and stop bomb-testing; the other is to take advantage of the fact that deep-frozen mammalian sperm will survive, with its fertilizing and genetic properties unimpaired, for a long period of time and perhaps indefinitely, and accordingly to build deep shelters for sperm-banks—collections of deep-frozen sperm from a representative sample of healthy and intelligent males. A complete answer must wait for the successful deep-freezing of ova also. But this may be achieved in the fairly near future, and in any case shelters for sperm-banks will give better genetic results than shelters for people, as well as being very much cheaper.

Positive eugenics has a far larger scope and importance than negative. It is not concerned merely to prevent genetic deterioration, but aims to raise human capacity and performance to a new level.

For this, however, it cannot rely on measures designed to produce merely a slight differential increase of genetically superior stocks, generation by generation. This is the way natural selection obtains its results, and it worked all right during the biological phase, when immense spans of time were available. But with the accelerated tempo of modern psychosocial evolu-

tion, much quicker results are essential. Luckily modern science is providing the necessary techniques, in the shape of artificial insemination and the deep-freezing of human gametes. The effects of superior germ-plasm can be multiplied ten or a hundredfold through the use of what I call E.I.D.—eugenic insemination by deliberately preferred donors—and many thousandfold if the superior sperm is deep-frozen.

This multiplicative method, harnessing man's deep desires for a better future, was first put forward by H. J. Muller and elaborated by Herbert Brewer, who invented the terms *euteleogenesis* and *agapogeny* for different aspects of it. Some such method, or what we may term Euselection—deliberate encouragement of superior genetic endowment—will produce immediate results. Couples who adopt this method of vicarious parenthood will be rewarded by children outstanding in qualities admired and preferred by the couple themselves.

When deep-frozen ova too can be successfully engrafted into women, the speed and efficiency of the process could of course be intensified.

Various critics insist on the need for far more detailed knowledge of genetics and selection before we can frame a satisfactory eugenic policy or even reach an understanding of evolution. I can only say how grateful I am that neither Galton nor Darwin shared these views, and state my own firm belief that they are not valid. Darwin knew nothing—I repeat *nothing*—about the actual mechanism of biological variation and inheritance: yet he was possessed of what I can only call a common-sense genius which gave him a general understanding of the biological process and enabled him to frame a theory of the process whose core remains unshaken and which has been able successfully to incorporate all the modifications and refinements of recent field study and genetic experiment.

Neither did the automatic process of natural selection "know" anything about the mechanisms of evolution. Luckily this did not prevent it from achieving a staggering degree of evolutionary transformation, including miracles of adaptation and improvement. From his seminal idea, Darwin was able to deduce important general principles, notably that natural selection would automatically tend to produce both diversifica-

tion (adaptive radiation) and improvement (biological advance or progress) in organization, but that lower types of organization would inevitably survive alongside higher.

Critics of positive eugenics like Medawar inveigh against what they call "*geneticism*." However, he himself is guilty on this count, for he has swallowed the population geneticists' claim (which I have discussed earlier) that theirs is the only scientifically valid definition of *fitness*; and this in spite of his admission that one organic type can be more "advanced" than another, and that "human beings are the outcome of a process which can perfectly well be described as an advancement." However, he equates advancement with mere increase in complexity of the "genetical instructions" given to the animal: if he had thought in broad evolutionary instead of restricted genetic terms he would have seen that biological advance involves improved organization of the phenotype; that fitness in the geneticist's sense is a purely reproductive fitness; and that we must also take into account immediate phenotypic fitness and long-term evolutionary fitness. To put it in a slightly different way, "fitness" as measured by differential survival of offspring is merely the mechanism by which the long-term improvement of true biological fitness is realized.

Recent genetic studies have shown the widespread occurrence of genetic polymorphism, in animal species and man, whether in the form of sharply distinct morphs (as with colour-blindness and other sensory morphisms), in multiplicity of slightly different alleles, or merely in a very high degree of potential variance. Some critics of positive eugenics maintain that this state of affairs will prevent or at least strongly impede any large-scale genetic improvement, owing to the resistance to change offered by genetic polymorphisms maintained by means of heterozygote advantage, which appear to comprise the majority of polymorphic systems.

It has further been suggested, notably by Professor Penrose, that people heterozygous for genes determining general intellectual ability, and therefore of medium or mediocre intelligence, are reproductively "fitter"—more fertile—than those of high or low intelligence, and accordingly that, as regards genetic intelligence,

the British population is in a state of natural balance. If so, it would be difficult to try to raise its average level by deliberate selective measures, and equally difficult for the level to sink automatically as the result of differential fertility of the less intelligent groups.

Although Medawar (op. cit. p. 125) appears to disagree with Penrose's main contention, he concludes that: "If a tyrant were to attempt to raise the intelligence of all of us to its present maximum . . . I feel sure that his efforts would be self-defeating: the population would dwindle in numbers and, in the extreme case, might die out." It is true that he later enters a number of minor caveats, but his main conclusion remains. This to me appears incomprehensible. If selection has operated, as it certainly has done in the past, during the passage from *Pithecanthropus* to present-day man, to bring about a very large rise in the level of genetic intelligence, why can it not bring about a much smaller rise in the immediate future? There are no grounds for believing that modern man's system of genetic variance differs significantly from that of his early human ancestors.

As regards balanced morphisms, it is of course true that they constitute stable elements in an organism's genotype. However, when their stability is mainly due to linkage with a lethal, and therefore to double-dose disadvantage rather than to heterozygote advantage, they may be destabilized by breaking the linkage. In any case, morphisms stable in one environment may sometimes be broken up in another. This has happened, for instance, with the white-yellow sex-limited morphism of the butterfly *Colias eurythema*, which in high latitudes has ceased to exist, and the local population is monomorphic, all homozygous white.

Certainly some morphisms show very high stability. For instance the PTC (phenylthiocarbamide) taste morphism occurs in apparently identical form both in chimpanzees and man, and so must presumably have resisted change for something like 10 million years. However, this remarkable stability of a specific genotypic component of the primate stock has not prevented the transformation of one branch of that stock into man!

Similar arguments apply to linked polygenic

systems and to the general heterozygosity in respect of small allelic differences shown by so many organisms, including man. In the former case, Mather has shown how selection can break the linkage and make the frozen variability available for new recombinations and new evolutionary change. In the latter case, the stability need not be so intense as with clear-cut morphisms.

Frequently, it appears, polymorphism depends not so much on heterotic advantage as on a varying balance of advantage between the alleles concerned in different conditions: one allele is more advantageous in certain conditions, another in other conditions. The polymorphism is therefore a form of insurance against extreme external changes and gives flexibility in a cyclically or irregularly varying environment (Huxley 1955). Such loose polymorphic systems can readily be modified by the incorporation of new and the elimination of old mutant alleles and the incorporation of new ones in response to directional changes in environment. In any case, their widespread existence has not stood in the way of directional evolutionary change, including the transformation of a protohominid into man. Why should they stand in the way of man's further genetic evolution?

The same reasoning applies to those numerous cases where high genetic variance, actual or potential, is brought about by multiple genic polymorphism, when many genes of similar action exist, often in a number of slightly different allelic forms.

In all these cases the critics of eugenics have been guilty of that very "geneticism" which they deplore. They approach the subject from the standpoint of population genetics. If they were to look at it from an evolutionary standpoint, their difficulties would evaporate, and they would see that their objections could not be maintained.

Two further objections are often made to positive eugenics. One is by way of a question—who is to decide which type to select for? The other, which is by way of an answer to the first, is to assert that effective selection needs authoritarian methods and can only be put into operation by some form of dogmatic tyranny, usually stigmatized as intolerable or odious.

Both these objections reveal the same lack of understanding of psychosocial evolution as the genetical objections revealed about biological evolution: more simply, they demonstrate the same lack of faith in the potentialities of man that the purely genetical objections showed in the actual operative realizations of life.

For one thing, dogmatic tyranny in the modern world is becoming increasingly self-defeating: partly because it is dogmatic and therefore essentially unscientific, partly because it is tyrannical and therefore in the long run intolerable. But the chief point is that human improvement never works solely or even mainly by such methods and is doing so less and less as man commits himself more thoroughly to the process of general self-education.

Let me take an example. Birth-control resembles eugenics in being concerned with that most violent arouser of emotion and prejudice, human reproduction. However, during my own career, I have witnessed the subject break out of the dark prison of taboo into the international limelight. It was only in 1917 that Margaret Sanger was given a jail sentence for disseminating birth-control information. In the late twenties, when I was already over forty, I was summoned before the first Director-General of the B.B.C., now Lord Reith, and rebuked for having contaminated the British ether with such a shocking subject. Yet two years ago an international gathering in New York paid tribute to Margaret Sanger as one of the great women of our age. *Time* and *Life* Magazines both published long and reasoned articles on how to deal with the population explosion, and two official U.S. committees reported in favour of the U.S. conducting more research on birth-control methods and even of giving advice on the subject if requested by other nations. And to-day one can hardly open a copy of the most respectable newspapers without finding at least one reference to the grievous effects of population increase and population density on one or another aspect of human life in one or another country of the globe, including our own. Meanwhile, six nations have started official policies of family planning and population control, and many others are unofficially encouraging them.

Birth-control, in fact, has broken through—

and in so doing it has changed its character and its methods. It began as a humanitarian campaign for the relief of suffering human womanhood, conducted by a handful of heroic figures, mostly women. It has now become an important social, economic and political campaign, led by powerful private associations, and sometimes the official or semi-official concern of national governments. Truth, in fact, prevails—though its prevailing demands time, public opprobrium of the self-sacrificing pioneers at the outset, and public discussion, backed by massive dissemination of facts and ideas, to follow.

We can safely envisage the same sort of sequence for evolutionary eugenics, operating by what may be called Euselection, though doubtless with much difference in detail. Thus the time to achieve public breakthrough might be longer because the idea of Euselection by delegated paternity runs counter to a deep-rooted sense of proprietary parenthood. On the other hand it might be shorter, since there is such a rapid increase in the popular understanding of science and in the agencies of mass communication and information, and above all because of the profound dissatisfaction with traditional ideas and social systems, which portends the drastic recasting of thought and attitude that I call the Humanist Revolution.

Some things, at least, are clear. First, we need to establish the legality, the respectability, and indeed the morality of A.I.D. It must be cleared of the stigma of sin ascribed to it by Church dignitaries like Lord Fisher when Archbishop of Canterbury, and from the legal difficulties to its practice raised by the lawyers and administrators. Most importantly, the notion of donor secrecy must be abolished. Parents desiring A.I.D. should have not only the right but the duty of choice. For the time being, it may possibly be best that the name and personal identity of a donor should not be known to the acceptors, but there should certainly be a register of certified donors kept by medical men (and I would hope by the National Health Service) which would give particulars of their family histories. This would enable acceptors to exert a degree of conscious selection in choosing the father of the child they desire, and so pave the way for the supersession of blind and secrecy-

ridden A.I.D. by an open-eyed and proudly accepted E.I.D. where the E stands for *Eugenic*.

The pioneers of E.I.D., whether its publicists or its practitioners, will undoubtedly suffer all kinds of abusive prejudice—they will be accused of mortal sin, of theological impropriety, of immoral and unnatural practices. But they can take heart from what has happened in the field of birth-control, and can be confident that the rational control of reproduction aimed at the prevention of human suffering and frustration and the promotion of human well-being and fulfilment will in the not too distant future come to be recognized as a moral imperative.

The answers to the questions I mentioned at the beginning of this section are now, I hope, clear. There will be no single type to be selected for, but a range of preferred types; and this will not be chosen by any single individual or committee. The choice will be a collective choice representing the varied preferences and ideals of all the couples practising euselection by E.I.D., and it will not be dogmatically imposed by any authoritarian agency, though as general acceptance of the method grows, it will be reinforced by public opinion and official leadership. The way is open for the most significant step in the progress of mankind—the deliberate improvement of the species by scientific and democratic methods.

All the objections of principle to a policy of positive eugenics fall to the ground when the subject is looked at in the embracing perspective of evolution, instead of in the limited perspective of population genetics or the short-term perspective of existing socio-political organization. Meanwhile the obvious practical difficulties in the way of its execution are being surmounted, or at least rendered surmountable, by scientific discovery and technical advance.

In evolutionary perspective, eugenics—the progressive genetic improvement of the human species—inevitably takes its place among the major aims of evolving man. What should we eugenists do in the short term to promote this long-term aim? We must of course continue to do and to encourage research on human genetics and reproduction, including methods of conception-control and sterilization. The establish-

ment of the Darwin Research Fellowships is an important milestone in this field: I hope that we shall be able to enlarge our research activities in the future.

We must continue to support negative eugenic measures, especially perhaps in respect of the so-called Social Problem group. We should assuredly continue to be concerned about population increase, and to support all agencies and organizations aiming at sane and scientific policies of population-control. We must equally support all agencies giving eugenic advice and marriage guidance. Since significant eugenic improvement depends on donor insemination, we must do all we can to win public support for A.I.D., and to improve current practices in the subject.

In general, we must bring home to the general public the possibility of real genetic improvement, the burden it could lift off human shoulders, the hope it could kindle in human hearts. We must make people understand that social and cultural amelioration are not enough. If they are not to turn into temporary palliatives or degenerate into mere environmental tinkering, they must be combined with genetic amelioration, or at least with the hope of it in the future.

To ensure this, not only must the eugenics movement help to educate the public and especially the members of the professions—medical, educational, scientific, administrative, and others—in respect of eugenics, but it must make every effort to get the educational system improved at all levels, so as to provide everyone with the necessary minimum of biological understanding—an understanding of reproduction and population, genetics and selection, ecology and conservation, and above all of the process of evolution in its awe-inspiring sweep and of man's specific significance and responsibility in that comprehensive process.

If, as I firmly believe, man's role is to do the best he can to manage the evolutionary process on this planet and to guide its future course in a desirable direction, fuller realization of genetic possibilities becomes a major motivation for man's efforts, and eugenics is revealed as one of the basic human sciences.

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